Earth Prediction Innovation Center (EPIC)

Perspectives from the JCSDA

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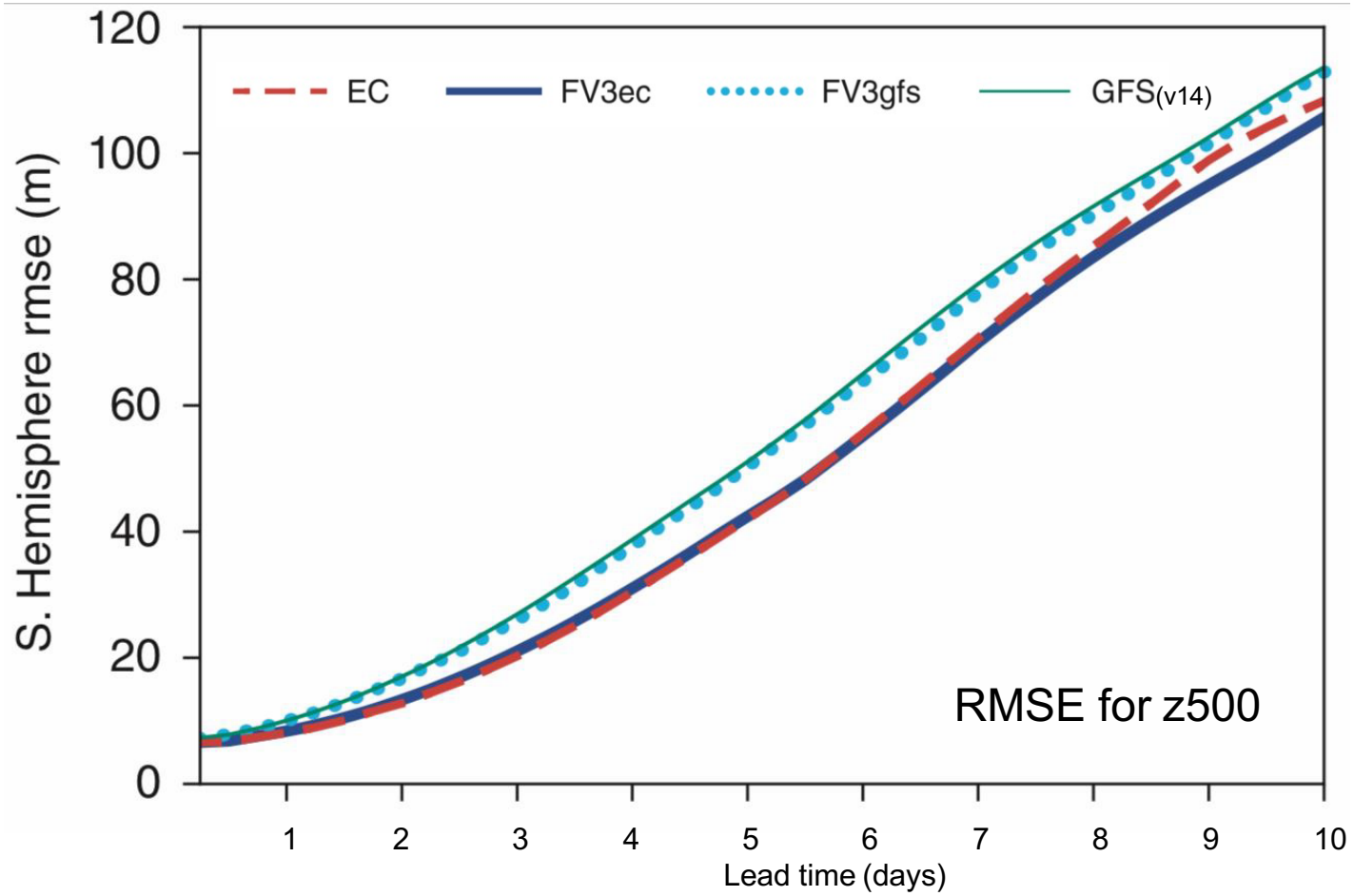
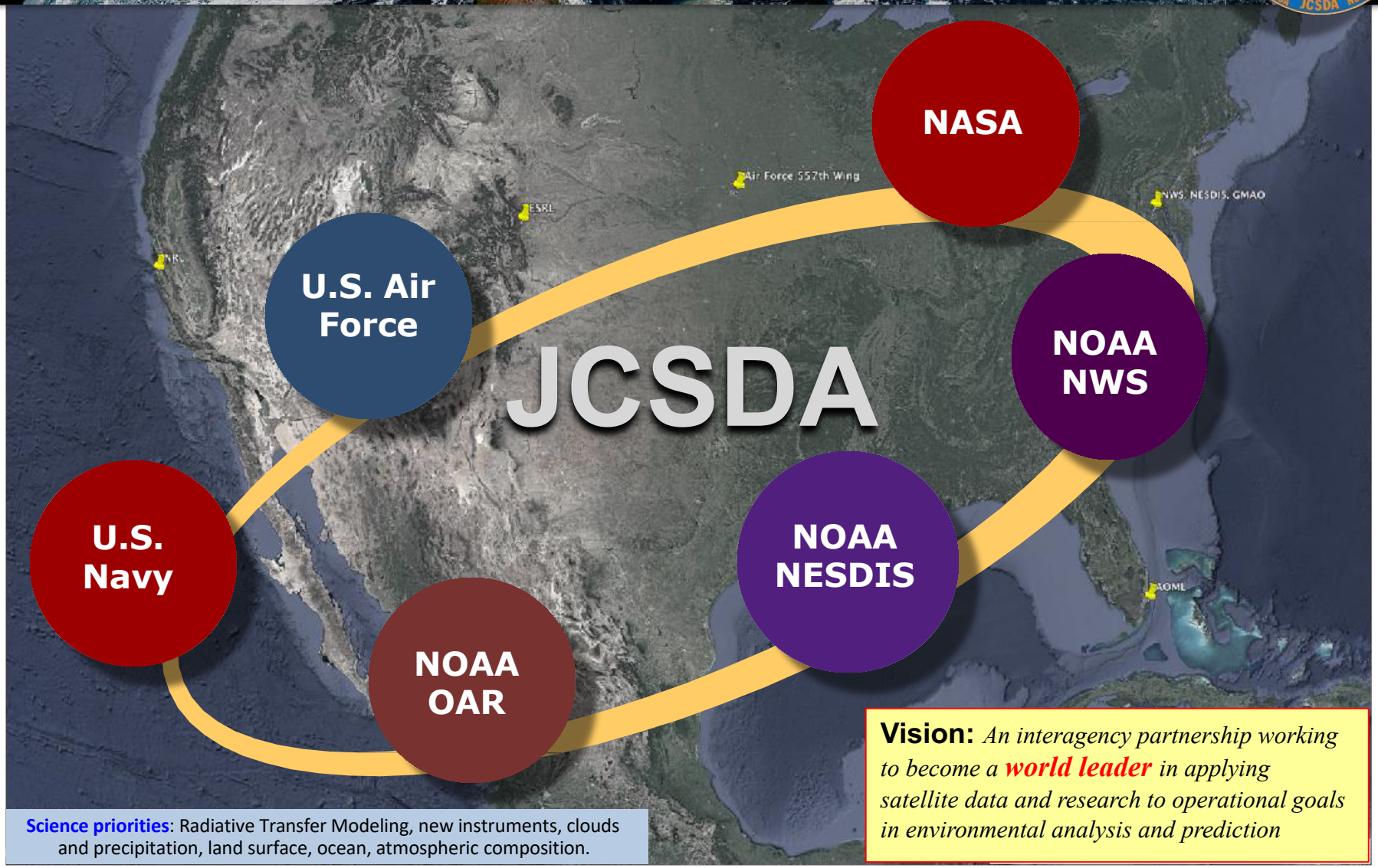
Introduction

EPIC Legislation: Advancing weather modeling skill, reclaiming and maintaining international leadership in the area of numerical weather prediction



Magnusson et al. (2019)

Joint Center for Satellite Data Assimilation



Science priorities: Radiative Transfer Modeling, new instruments, clouds and precipitation, land surface, ocean, atmospheric composition.

Vision: *An interagency partnership working to become a* ***world leader*** *in applying satellite data and research to operational goals in environmental analysis and prediction*

Joint Effort for Data assimilation Integration (JEDI)

- "The strength of a common goal" = one system with multiple configurations
- JEDI is for **scientific exploration** and **operational forecasting** (incl. R2O2R)
- We want flexible, reliable, efficient, generic, readable and modular code. This is not specific to Earth system modeling: the software industry has moved to **generic** and **object-oriented** programming 20 years ago.
- Keys to success = **separation of concerns**, **interfaces,** and **reusable** components

Next-Generation Software: From Generic to Specific

NEPTUNE

FV3GFS

GEOS

MPAS

LFRic

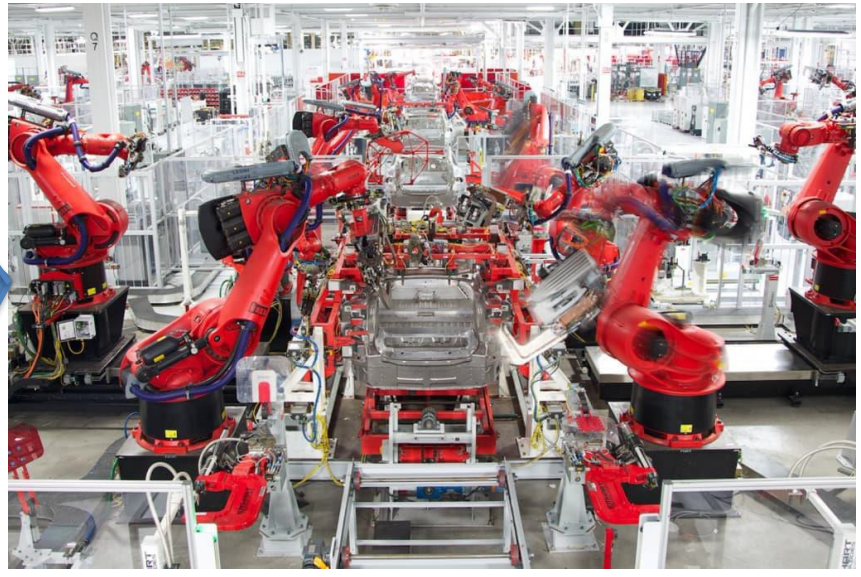
WRF

MOM6

CICE5

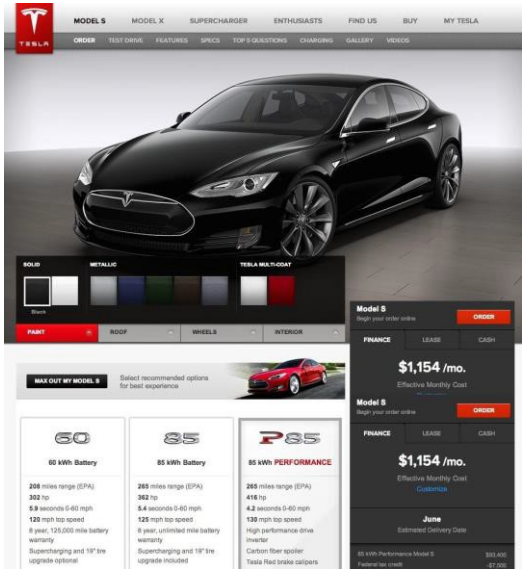
...

JEDI Software Framework



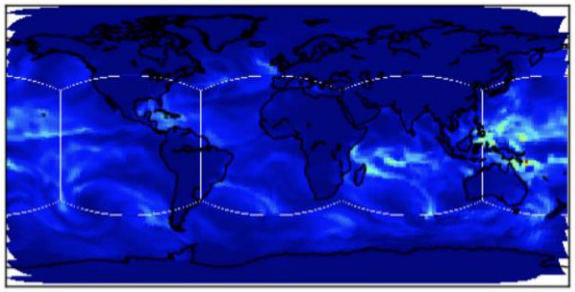
Templates (controlled by traits)

Factories (controlled by config)

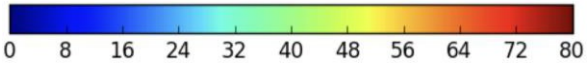


JEDI: One System with Multiple Configurations

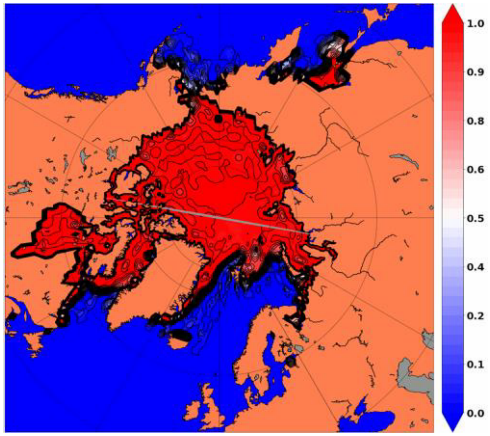
Analysis of lowest model layer
for: seas4 valid: 2018041506



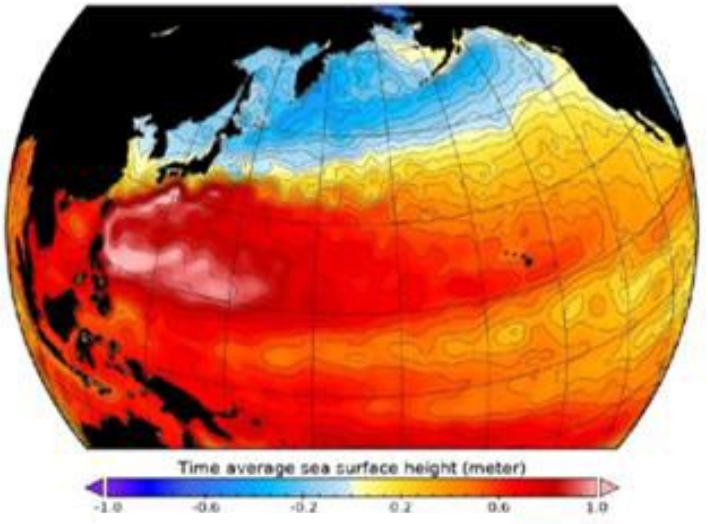
Analyzed aerosols



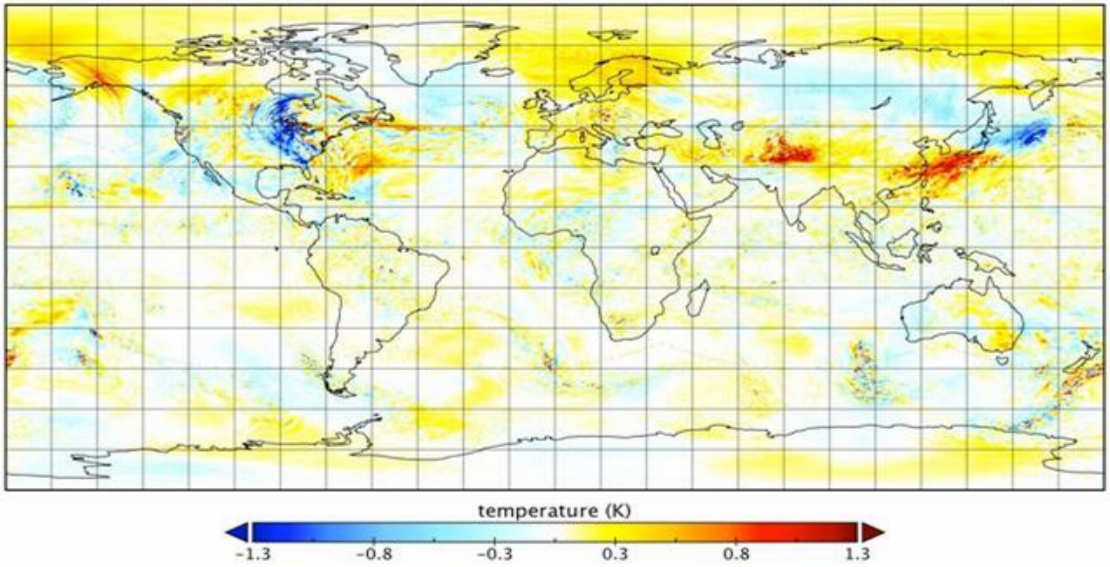
Analyzed ice fraction aggregate



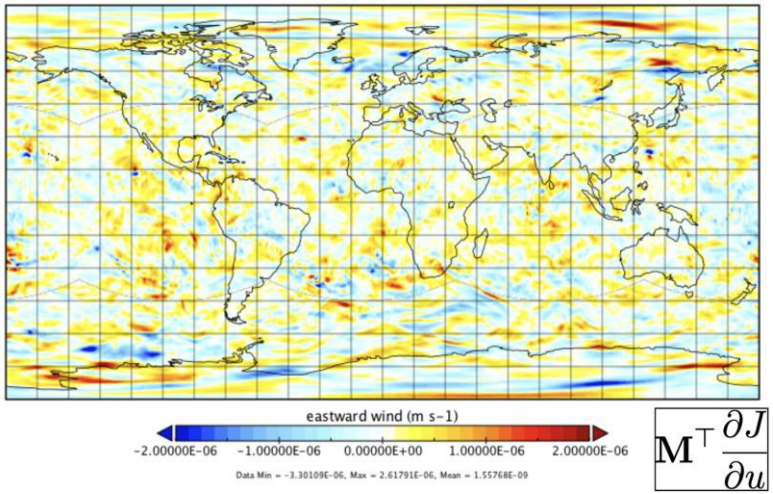
Analyzed Sea Surface Height (m)



200 hPa T increment propagated 24h by GFSv15 on AWS (1,728 cores) in 7min20s

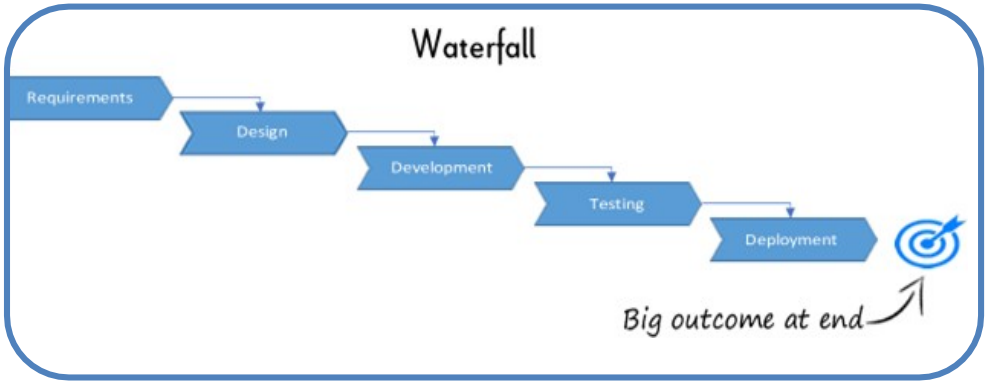


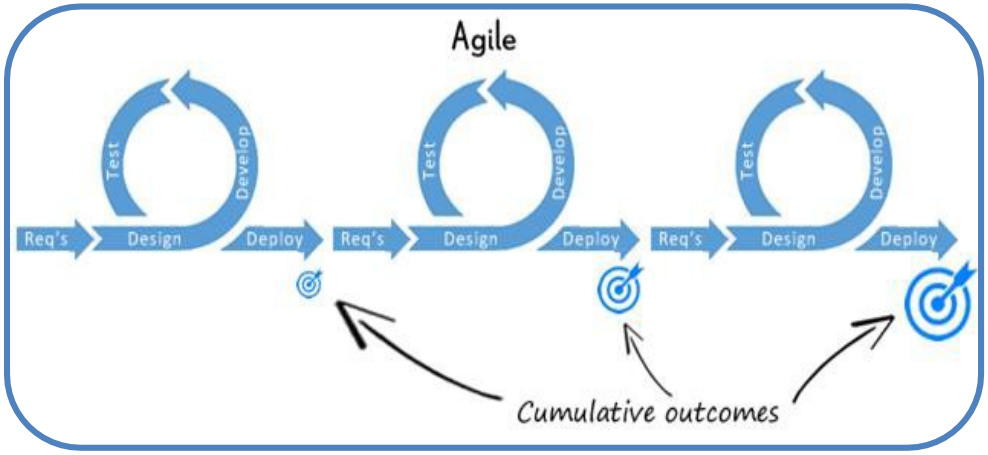
Adjoint Sensitivity to initial conditions @500 hPa



$$\mathbf{M}^{\top}\frac{\partial J}{\partial u}$$

JCSDA Ecosystem: from Waterfall to Agile





- Easy access to up-to-date open-source software for the community
- Agile development
- Automatic testing, CI/CD
- Hierarchical testing (cheap versions of operations)
- Collaborative peer reviews (developers = testers)
- Dynamic documentation
- Code portability

Community Engagement and Support

Outreach

- Workshops, seminars, newsletter, website

Planning

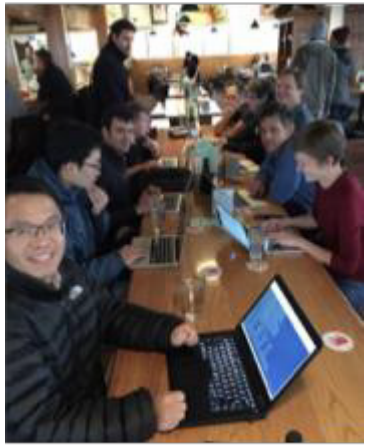
- Thematic planning meetings

Training

- Summer schools and tutorials

Development

- Visiting Scientist Program
- HPC support
- Code Sprints



JCSDA "Graduate Student Test"

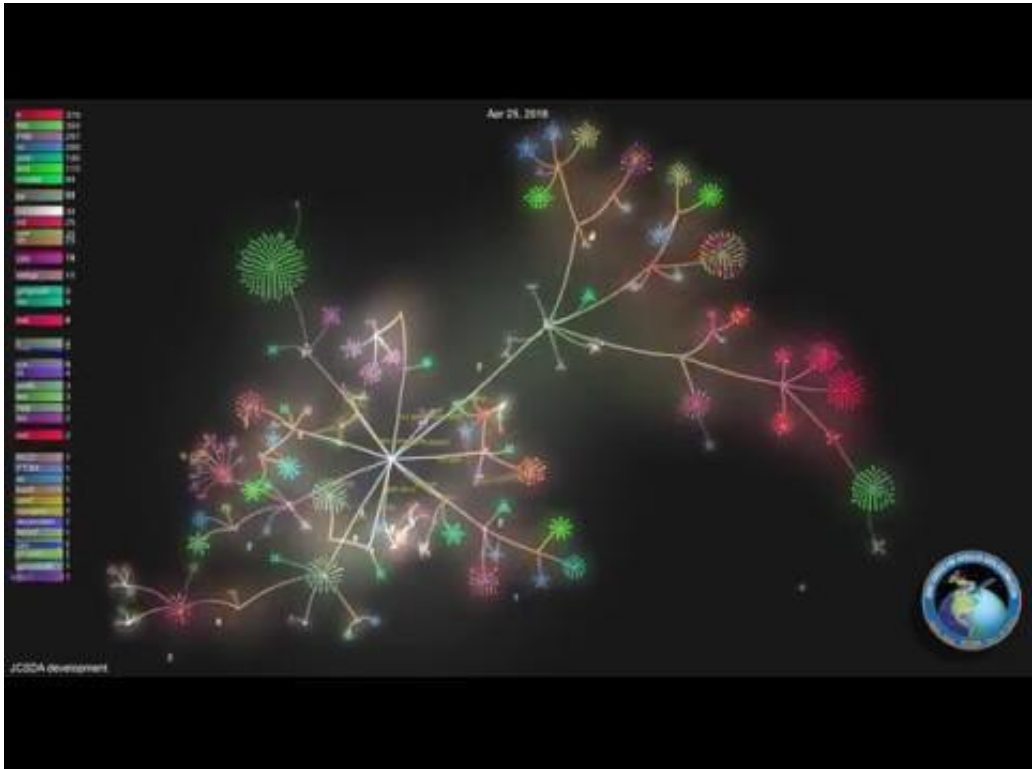
Example from latest JEDI Academy

1. fire up a machine on AWS Cloud, access latest code from multiple JCSDA Github repositories, build application, run test case (20 minutes)

1. submit issue ticket, submit new code, automatic testing (30 minutes)

1. peer-review (same day)

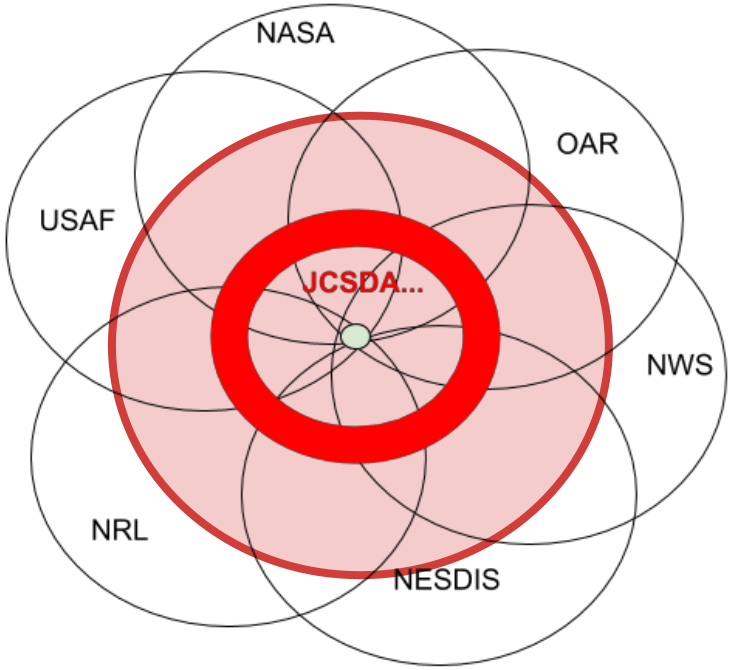
1. merge code to JCSDA Github (5 seconds)



The Quiet Revolution of Data Assimilation

Past

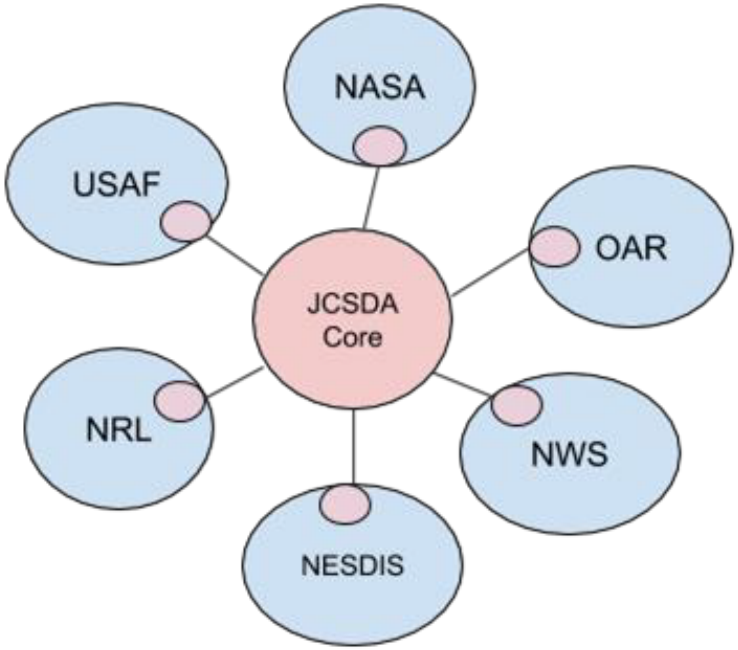
Virtual center (amalgamation)



Working groups → "Talking groups"

Present

Distributed center (integration)



Common operating plan, world-class staff (core and in-kind), lean management → results driven

Financially-independent labs (e.g. Met Office) requesting JCSDA developments for their research

Final Remarks and lessons learned for EPIC

Data Assimilation is a major foundation for EPIC to reclaim international leadership in NWP within 5-10 years.

Quiet revolution based on modern software practices, agile collaborative development, and community inclusion. All concepts scale to more models, applications, partnerships.

Center of excellence requires focus, world-class staff committed to success, and nimble decision making.


EPIC?
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NGGPS
JTTI
OWAQ
UFS
SIP
Fed. agencies
Academia
Private Sector
JCSDA
DTC
Testbeds
Proving Grounds
CMC
NCAR MoA
Initiatives
NOAA Labs
EMC
NCO
US Earth Prediction Enterprise

Discussion